

Ventilator-Associated Pneumonia (VAP): Pathogenesis, Definitions & Outcomes

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**“Remember
how much
you don’t
know.”**



William Osler

Thinking Outside the Box



- Pathogenesis?
- Diagnosis issues
- Microbiology models key
- Goals: better data & patient outcomes

VAP & Intensive Care!!

- ET: 6-21 fold > risk
- > 50% MICU antibiotics
- Mortality = 20%-50%
- Morbidity - huge
- Cost = \$15,000 - \$40,000



Chastre, Am J Resp Crit Care Med 2002: 165:867-03

I. Pathogenesis:

Colonization

vs

Infection (VAT/VAP)

Nasopharyngeal Colonization



Bacteria/Secretions
ETT Cuff leaks, Biofilm

Bacterial Pathogens:
Number, Type & Virulence

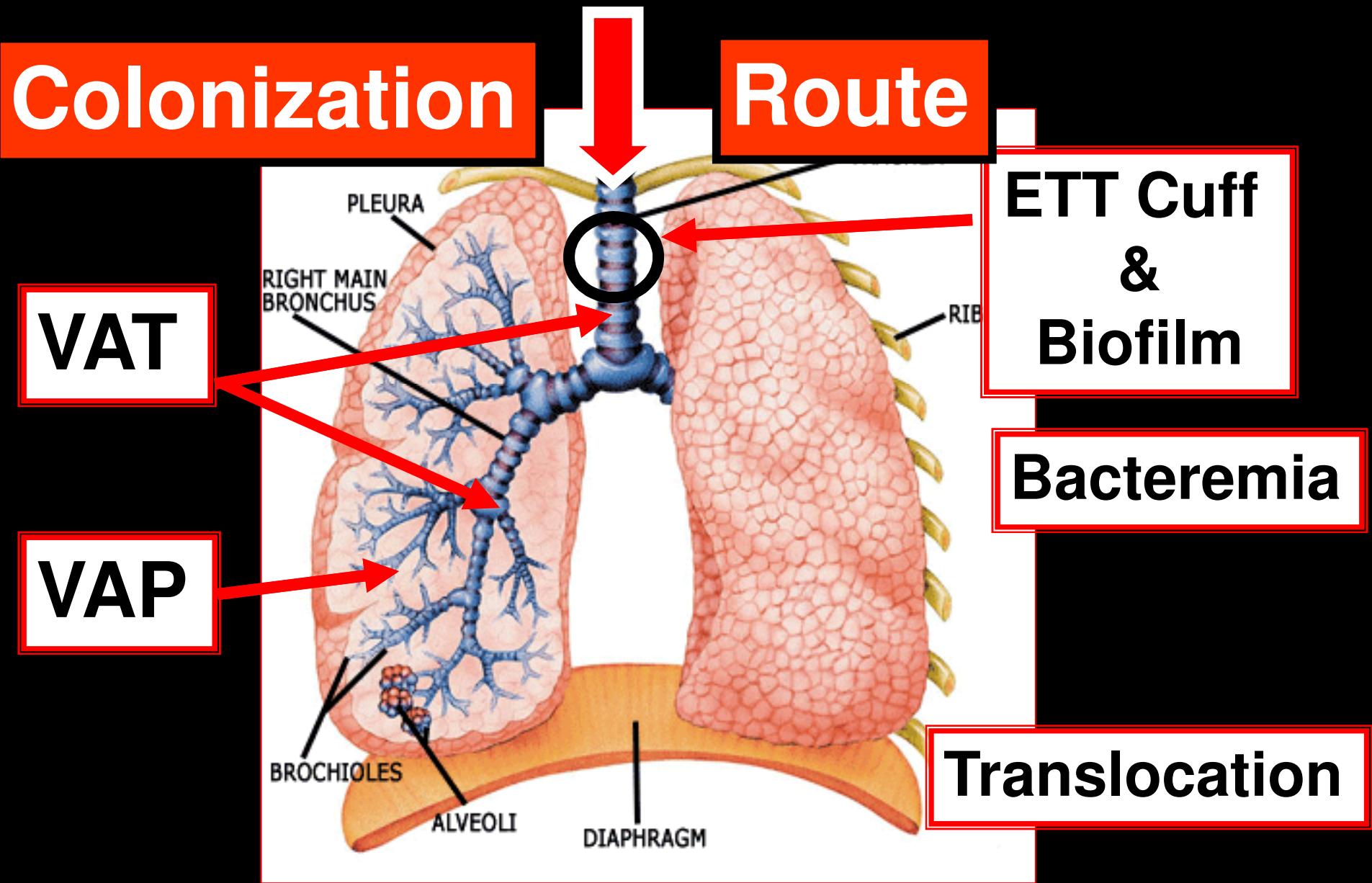
Lung Defenses:
Cilia, Humoral, Cellular

Tracheobronchial Colonization

VAT

VAP

BACTERIA: One-Way In & Out!

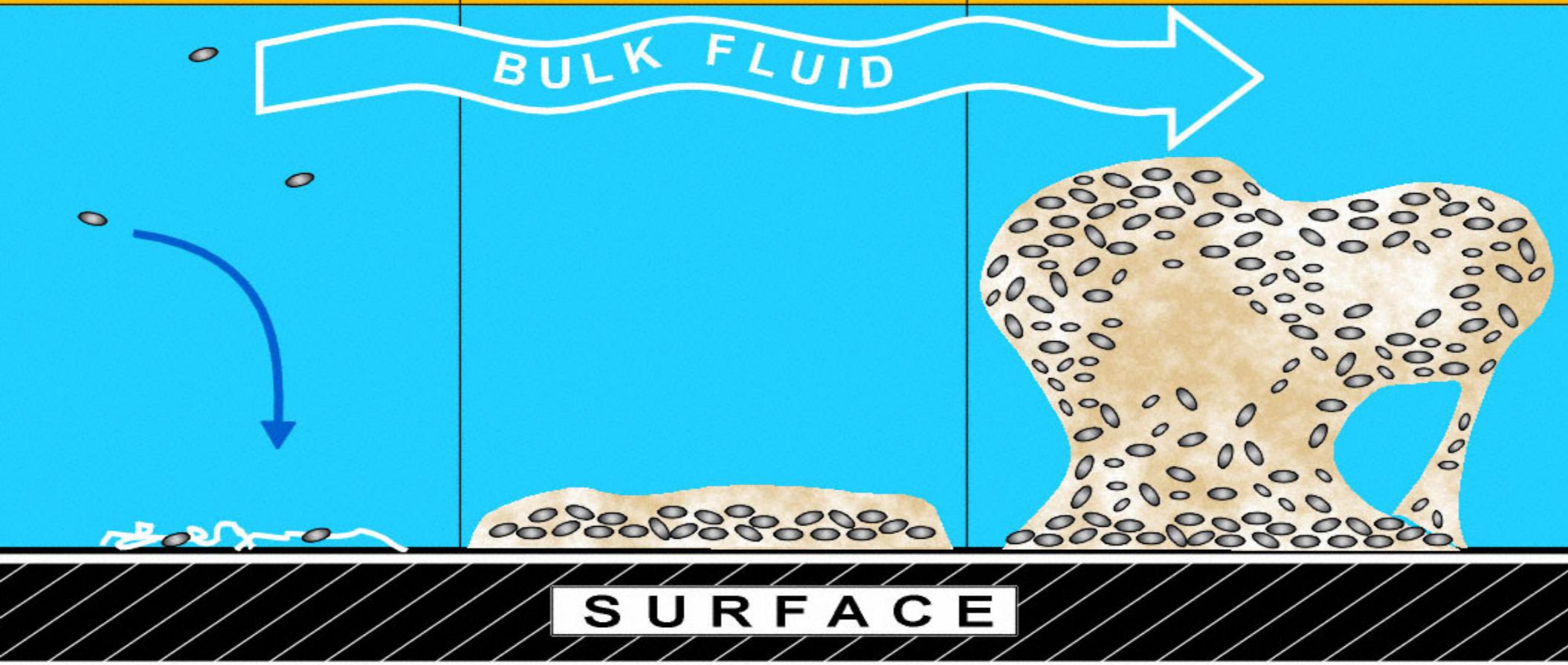


Biofilm formation: (E-tube)

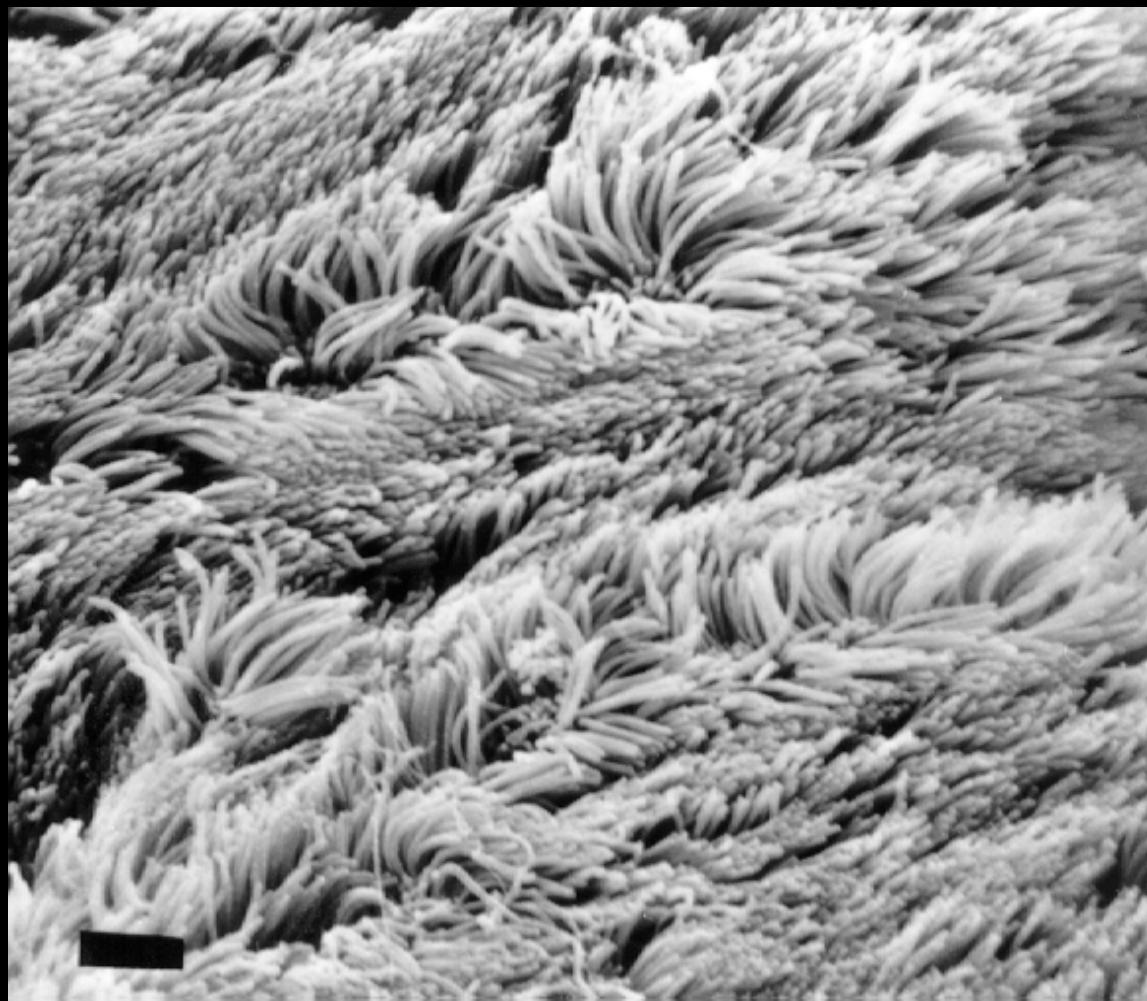
Attachment

Colonization

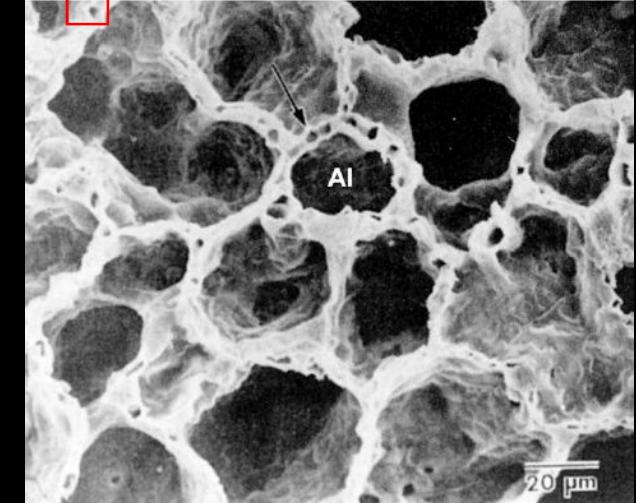
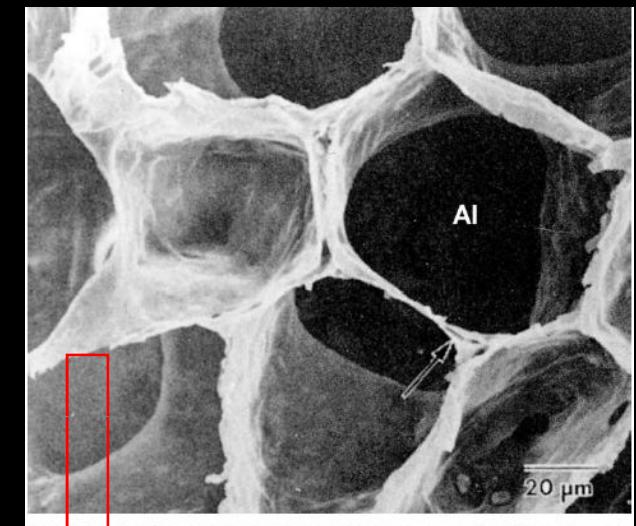
Growth



Ciliated Tracheal Epithelium



Alveoli



Dynamic Bacterial-Host Interactions

The Chase

This video is from a 16mm movie made in the 1950s by the late David Rogers; Vanderbilt University. It was given to me via Dr. Viktor Najjar, Professor Emeritus at Tufts University Medical School and a former colleague of Rogers.

Written by Tom Stossel, MD. 1999.
Digitally converted by Phil Allen, Ph.D. 1999.

VAP/VAT: Bacterial Pathogens

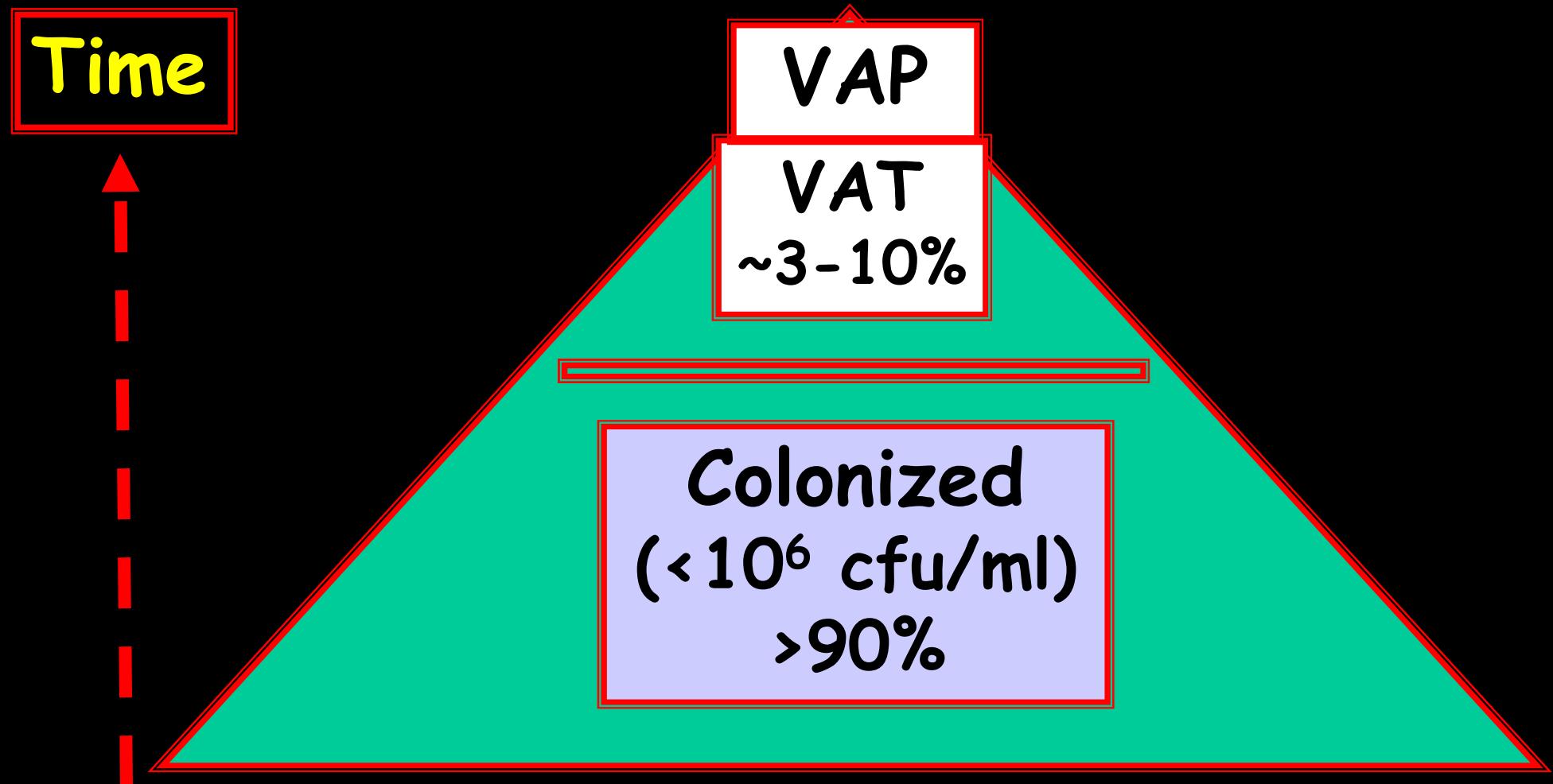
NOT

Viruses: FLU, RSV, HSV

Anaerobes, Legionella,

Candida or OIs

MVP > 48 hr: VAT & VAP Overlap



II. Definitions

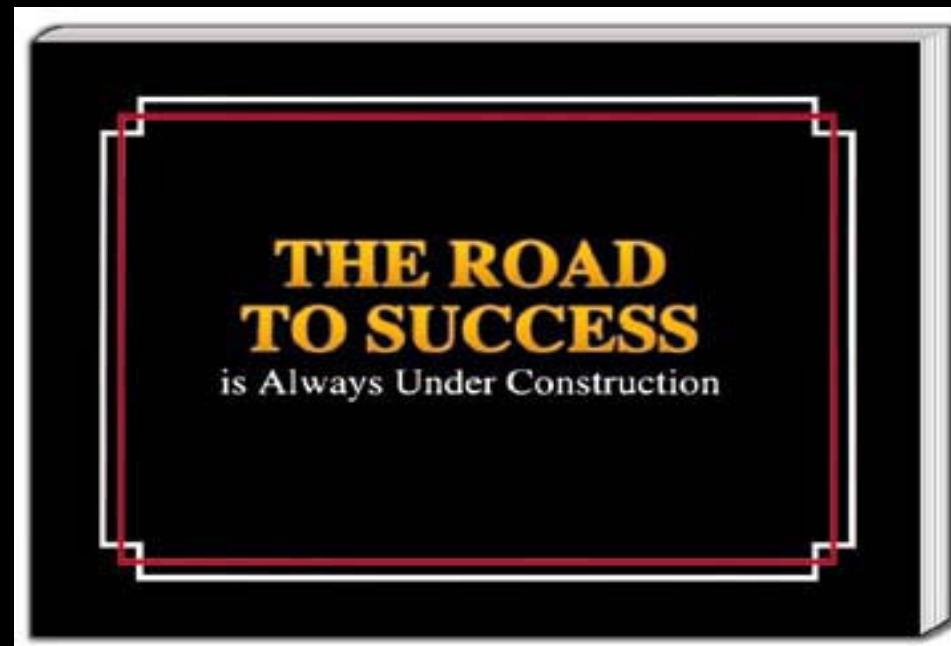
VAT

vs

VAP

VAP Surveillance & Outcomes

“The road to success
is always
under construction”



VAT/VAP Diagnosis = 1+2+3

1. Quantitative Microbiology: A Thermometer!!

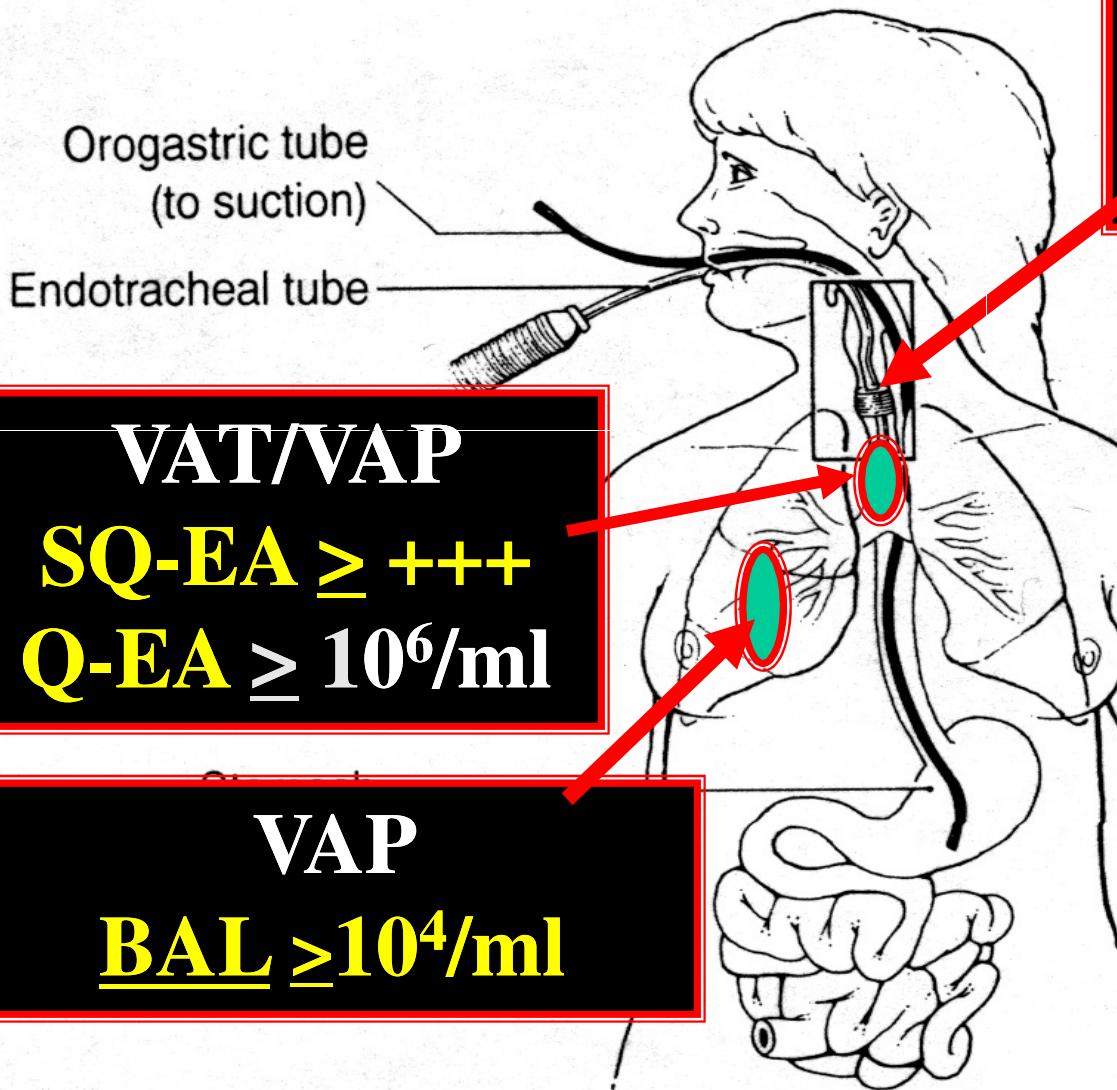
- BAL $\geq 10^4$ cfu/ml = VAP
- SQ-EA "moderate-heavy" = VAT or VAP
- Q-EA $\geq 10^6$ cfu/ml = VAT or VAP

2. Signs/Symptoms = VAT or VAP

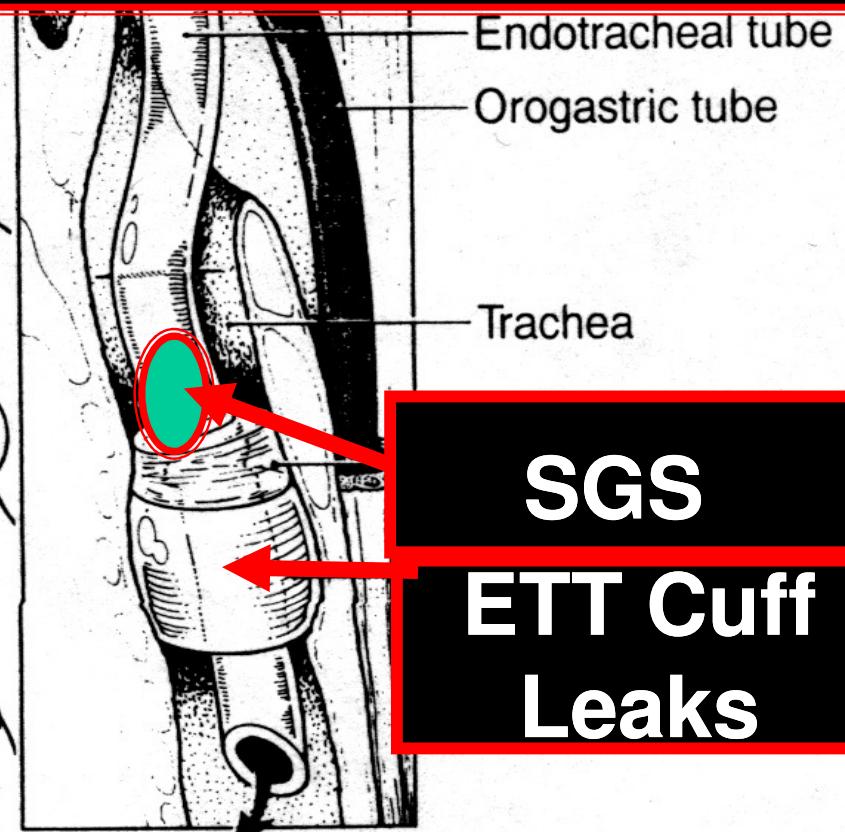
- Temperature: $>38C/100.4F$ or WBC $>12K$ or $<4K$
- New purulent sputum or change in FiO₂ or PEEP

3. Radiology: CXR: new & persistent infiltrate, consolidation, cavitation = VAP

VAT/VAP: A Numbers Game!



Nasopharynx
 $10^8\text{-}10^{10}$ orgs/ml



SQ-EA

+++ / +++++

Mod-Heavy

Q-EA

$\geq 10^{5-6}$

++

Rare, Few
Colonization

+

SQ-ETA Diagnostics

Diagnostic Tests for Pneumonia in Ventilated Patients: Prospective Evaluation of Diagnostic Accuracy Using Histology as a Diagnostic Gold Standard

CHARLES HUGO MARQUETTE, MARIE-CHRISTINE COPIN, FRÉDÉRIC WALLET, RÉMY NEVIERE,
FABIENNE SAULNIER, DANIEL MATHIEU, ALAIN DUROCHER, PHILIPPE RAMON,
and ANDRÉ BERNARD TONNEL

Marquette, ARRD 1995;151:1878-88

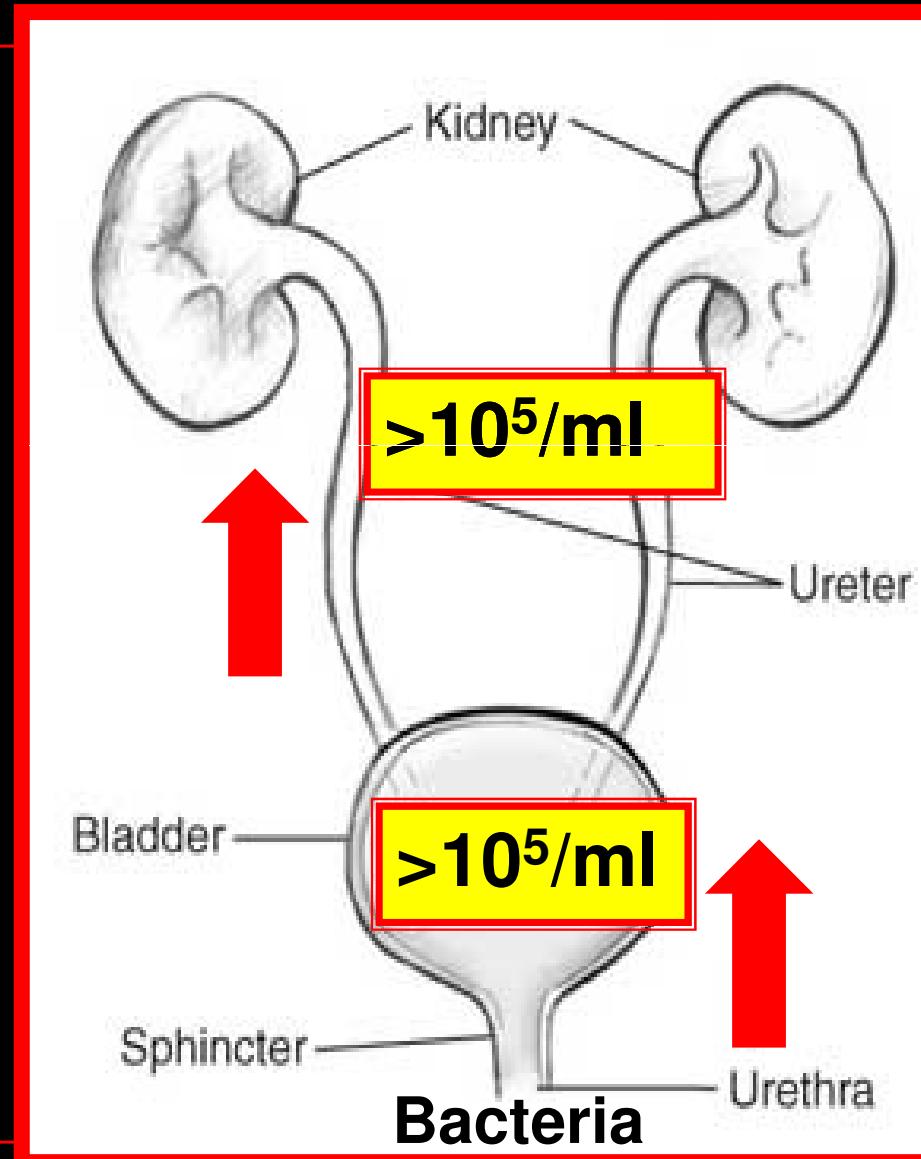
Q-EA ($\geq 10^6$)		BAL ($\geq 10^4$)	
Sens	Spec	Sens	Spec

55%	85%	47%	100%
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SENSITIVITY vs SPECIFICITY

Micro Model & UTI Diagnosis

- Kass's # ($>10^5$ cfu/ml)
- UTI symptoms
 - Pyuria, fever, WBC
 - Culture: $>10^5$ cfu/ml
- **NOT PERFECT!**



VAT or VAP? Treat? Report?

- 75M intubated >48 hr:
 - Temp >100.4 ° F
 - *WBC 11 k (75% polys)
 - ?Tan sputum (>25 PMN)
 - P/F ratio – no change
 - *CXR: infiltrate, ? new
 - *CPIs = 6

- SQ-EA
 - GS: polys/few GNR
 - Cultures: 24-48 hr.
- Dx: VAP or VAT?
- Rx: Treat or not?
- Report HAI or not?

VAT or VAP? Treat? Report?

Clinical

- Temp 100.5 ° F
- *WBC 12 k (75% polys)
- ?Tan sputum
- P/F ratio – no change
- *CPIs = 6

Radiology: **?RLL infiltrate**

- Microbiology
 - GS: polys/few GNR
 - Cultures: 24-48 hr.
- Surveillance EA:
 - Q-EA: GNR > 10^6 cfu/ml
 - SQ-EA: ++++ (heavy)
- BAL: > 10^4 cfu

When is a Chest "Infiltrate" VAP? Hawthorne or Administrator Effect!

Portable CXRs: Quality???

- o Sensitivity = Inflammation; ?Delay
- o Specificity = Low for Dx & Rx!
- o Key for "VAP" Diagnosis

CHF
ARDS
r/o Pn

?RLL
Pn

?LLL Pn
vs
atelectasis

VAT/VAP Principles

1. VAP = an infectious disease!
2. Quantitative microbiology KEY
Surveillance cultures?
3. Future: earlier, appropriate,
“targeted” therapy?
4. Goal: better outcomes

ATS/IDSA Guidelines for VAP Therapy

Am Rev Resp Crit Care Med 2005; 171: 388

1. Early, empiric, appropriate & adequate antibiotics based on MDR risk
2. De-escalate 48-72 hr: based on clinical response & culture results
3. Limit duration: 7-8 days

ARE WE WAITING TOO LONG TO INITIATE THERAPY?

Crude Diagnostics, Definitions,
DELAY = Increased Bacterial Numbers,
More Inflammation, Tissue Damage,
Complications & Worse Outcomes?

Surveillance VAT/VAP Model

Surveillance EAs
Pathogen GS, C&S



Diagnosis VAT/VAP
 $Q\text{-EA} = 10^6 \text{ cfu/ml}$
 $SQ\text{-EA} = \text{Mod-Heavy}$



Earlier, “**Targeted**”
Antibiotics/De-escalation

ATS/IDSA VAP Model

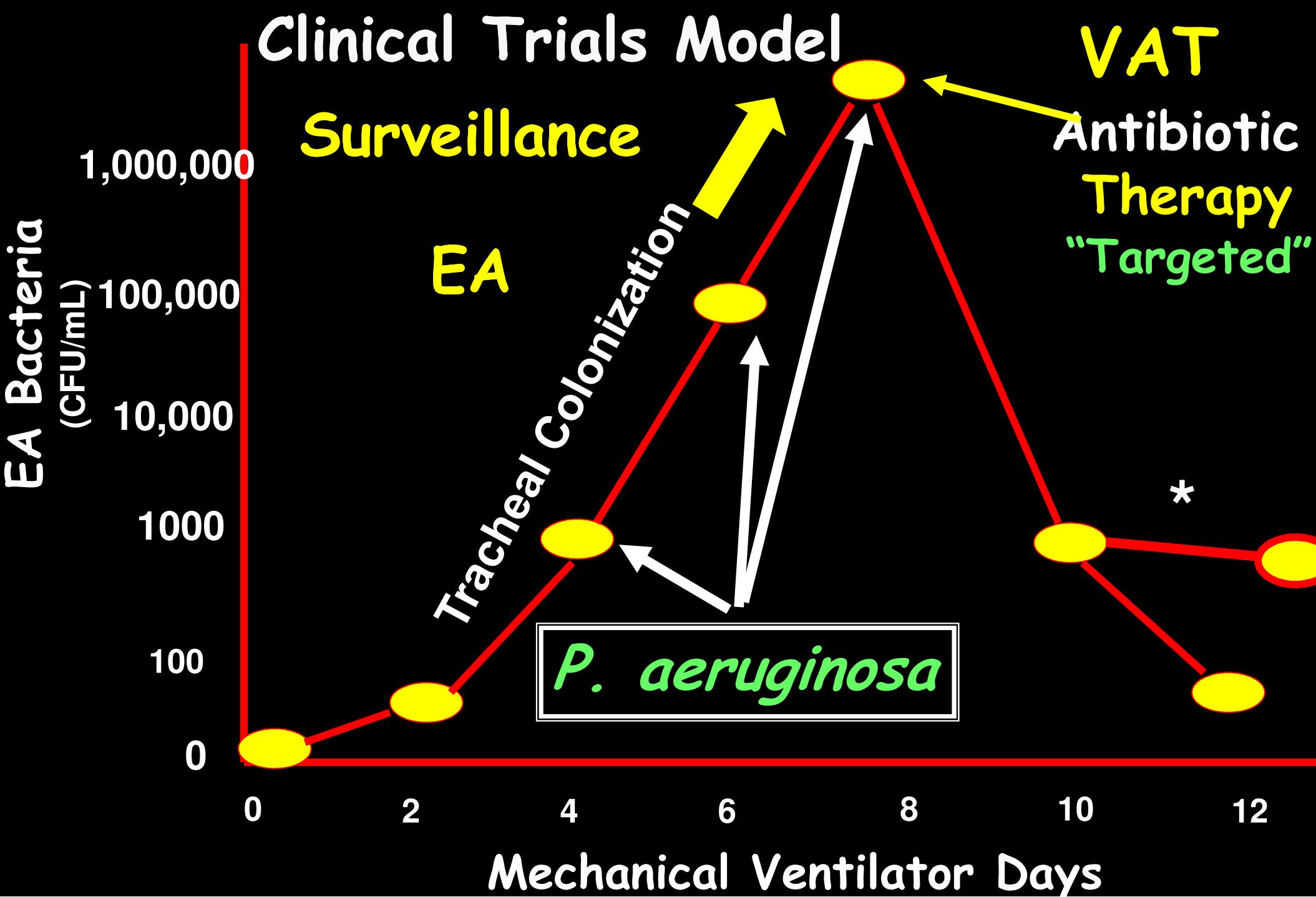
VAP Suspected
“**Broad Spectrum**”
Antibiotics



Pathogen EA/BAL
Micro: GS, EA/BAL
(48-72 hr Delay)



De-escalation



VAT: Epidemiology & Outcomes

MICU/SICU patients VAT: (Q-EA $\geq 10^6$),

- Incidence 3%-11%
- Outcomes: > ICU LOS, MV days, mortality
- Antibiotics: lower MICU mortality ($p < .04$)

RCT of VAT Therapy & Outcomes

- VAT: Q-EA $\geq 10^6$, CXR normal
- RCT: Antibiotics vs NO/Delayed therapy:
 - Reduced VAP: 14% vs 47% ($p=0.01$)
 - Reduced ICU mortality ($p<0.05$)
 - More MV-free days ($p<0.001$)
- Good outcomes, but limitations ($n=50$)

VAT Antibiotic Therapy

Early
VAP

Possible
VAP

VAP
Prevention

IMPROVED PATIENT OUTCOMES

VAP

vs.

VAT

Temperature, WBC, sputum

$\Delta \text{PaO}_2/\text{FiO}_2 > \text{PEEP}$

+ Pathogen (s)

CXR “New infiltrate”

Microbiology \$\$\$

- Q-EA: $>10^6 \text{ CFU/mL}$
- SQ-EA: mod - heavy
- BAL $>10^4 \text{ CFU/mL}$

Temperature, WBC,

Δ purulent sputum

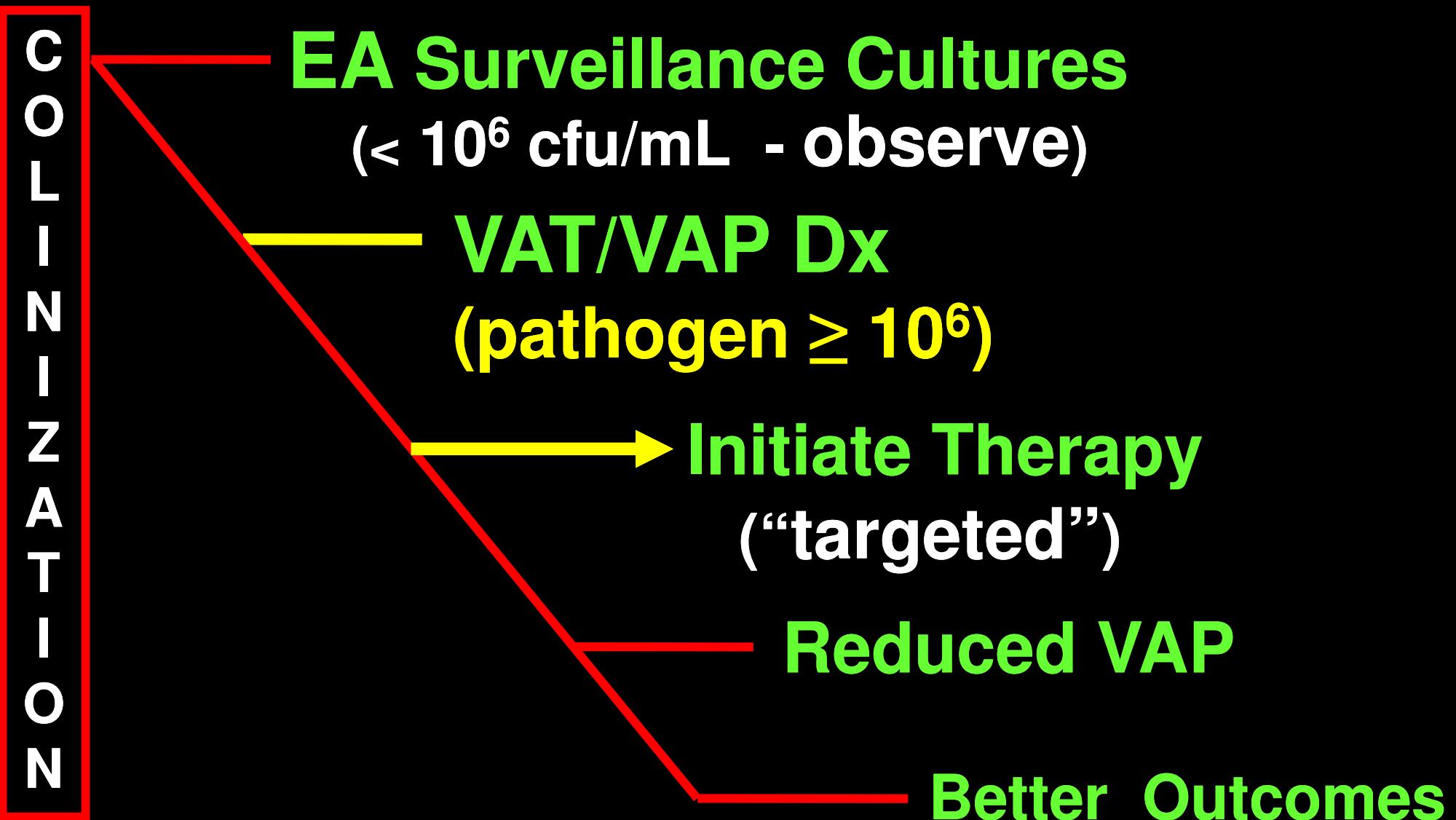
+ Pathogen (s)

CXR “Normal”, CHF, ARDS

Microbiology \$\$\$

- Q-EA $>10^6 \text{ CFU/mL}$
- SQ-EA: mod - heavy
- BAL $< 10^4 \text{ CFU/mL}$

VA-RTI : A Clinical Model



VAT/VAP (VA-LRI) Model: Advantages

- Standardized EA/BAL microbiologic diagnoses
- SQ-EA used in most hospitals: Q-EA simple
- Surveillance EA cultures may be useful
- Use of “targeted” vs “empiric” antibiotics
- VA-LRI: EA = endpoint for surveillance or QI

VAT/VAP: Suggestions

- Consider use of “VA-RTI” : VAT & VAP
- Focus on aerobic bacteria, “quantitative” cultures
- Target: intubated patients (no tracheostomies)
- Standardize Q-EA, SQ-EA, Q-BAL criteria
- Correlate microbiology data with CXR & clinical signs
- Measure impact of prevention & improved outcomes

VA-RTI (VAT/VAP) Model Issues

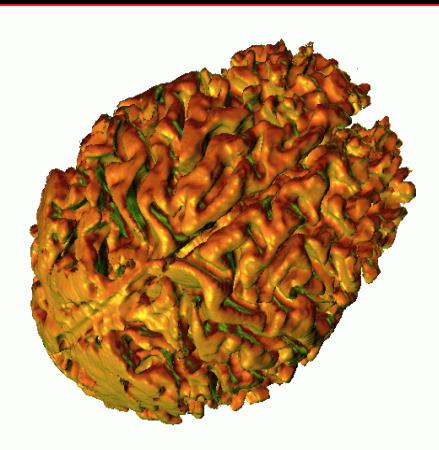
- Need better data & confirmatory studies
- Q-EA vs SQ-EA standards needed
- Incidence data & impact of VAT & VAP
- “Clinical” & surveillance data correlation

Thinking Out Side of the Box

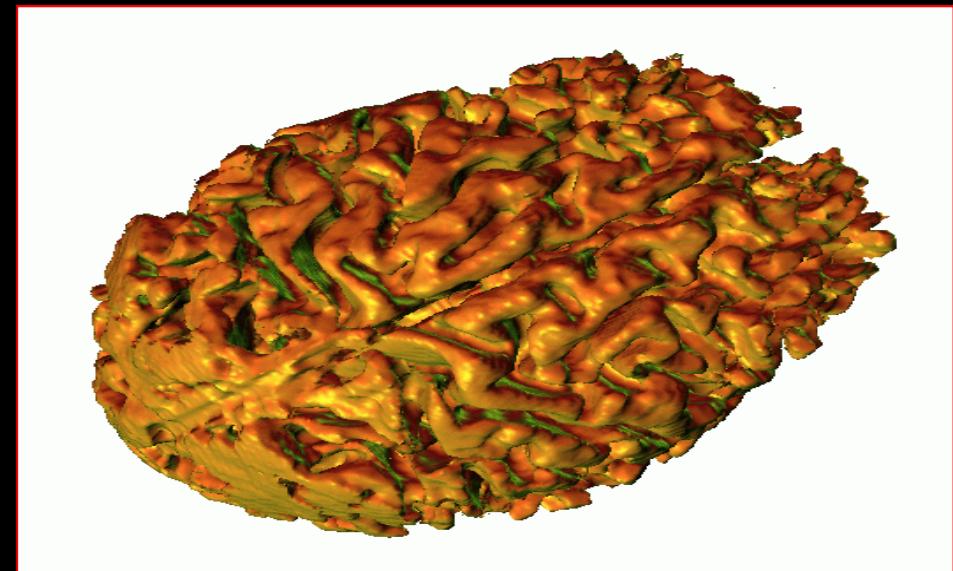
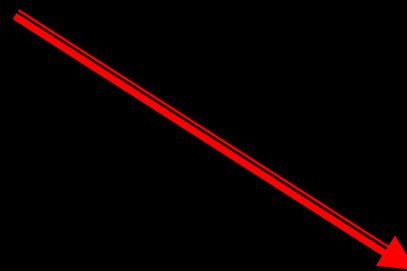
- VA-LRI: a surveillance endpoint?
- VAT & VAP may overlap
- VAT/VAP models useful in all hospitals
- Goals: VAP prevention & better outcomes

- Man's mind, once stretched
- by a new idea,
- never regains its original dimension.

• -- Oliver Wendell Holmes



Before



After

Craven Disclosures

- Research: Pfizer, Bard
- Honoraria: Merck, Pfizer, Ortho-McNeill,
Covidien, Sanofi Pasteur, Bard